DOCUMENT RESUME

ED 252 413 SE 045 335

AUTHOR Nelsen, David
TITLE Oxidation Ditches. Instructor's Guide. Biological Treatment Process Control.
INSTITUTION Linn-Benton Community Coll., Albany, Oreg.
SPONS AGENCY Environmental Protection Agency, Washington, D. C.
PUB DATE 84
GRANT EPA-T901238
NOTE 19p.; For related documents, see SE 045 333-354.
AVAILABLE FROM Linn-Benton Community College, 6500 S.W. Pacific Blvd., Albany, OR 97321 (Instructor's Guide and accompanying slides).
PUB TYPE Guides - Classroom Use - Guides (For Teachers) (052)

EDRS PRICE MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS *Biology; Laboratory Procedures; Microbiology; *Oxidation; Post Secondary Education; *Sludge; *Training Methods; Waste Disposal; *Waste Water; *Water Treatment
IDENTIFIERS *Oxidation Ditches; Unit Processes

ABSTRACT

This instructor's guide contains materials needed for teaching a two-lesson unit on oxidation ditches. These materials include: (1) an overview of the two lessons; (2) lesson plans; (3) lecture outlines; (4) student worksheet (with answers); and (5) two copies of a final quiz (with and without answers). The first lesson: reviews the theory, structure, and components of the oxidation ditch system; discusses nitrification/denitrification and its importance to oxidation ditch operation; and outlines and explains process monitoring and process control techniques. (This lesson is designed to be presented with the aid of a set of 35mm slides accompanying the unit.) The second lesson, which is more advanced, covers the topics of carbonaceous and nitrogenous oxidation and their importance in oxidation ditch process control. Since this lesson could be considered optional for instruction at the intermediate level, the student worksheet and final quiz cover only the material presented in the first lesson. (JN)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED252413

Biological Treatment Process Control

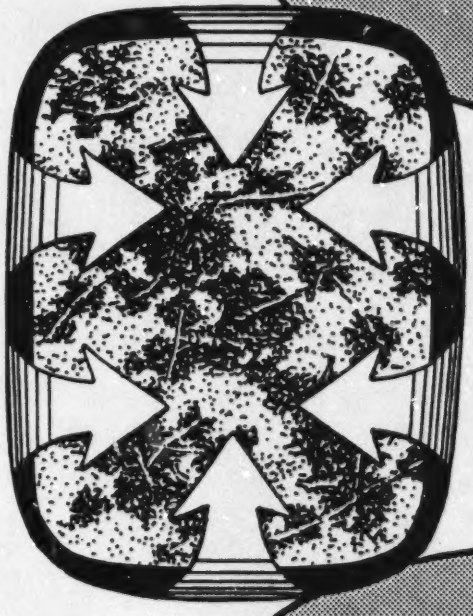
U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

Oxidation Ditches



Instructor's Guide

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

John W. Carnegie

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

Linn-Benton Community College
Albany, Oregon 1984

SE 045 335

BIOLOGICAL TREATMENT PROCESS CONTROL

OXIDATION DITCHES

INSTRUCTOR'S GUIDE

Text Written By:
David Nelsen
Envirotech Operating Service
San Mateo, California

Edited By:
John W. Carnegie, Ph.D.
Project Director
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin, Ph.D.
Priscilla Hardin Instructional Services
Corvallis, Oregon

Developed Under:
EPA Grant #T901238
1984

OXIDATION DITCHES

Instructor's Guide

Table of Contents

	Page #
Overview of Lessons	I-OX-1
Lesson Plans	I-OX-1
Lecture Outline	I-OX-3
Lesson I - Introduction, Theory & Components	I-OX-3
Lesson II - Process Kinetics & Process Control	I-OX-5
Answers to Worksheet Problems	I-OX-8
Final Quiz	I-OX-10
Answers to Final Quiz	I-OX-13
Copy of Student Materials	

OXIDATION DITCHES

Overview of Lessons

This unit on Oxidation Ditches is divided into two lessons. Lesson I reviews the theory, structure, and components of the oxidation ditch system. Nitrification/Denitrification is discussed and its importance to oxidation ditch operation explained. Process monitoring and process control techniques are outlined and discussed. Lesson I is designed to be presented with the aid of the 35 mm slides accompanying this unit.

Lesson II does not have slide support. This lesson, which is more advanced, covers the topics of carbonaceous and nitrogenous oxidation and their importance on oxidation ditch process control. This lesson could be considered optional for instruction at the intermediate level. Therefore, the worksheet and final quiz cover only the material presented in Lesson I.

Lesson Plans

Lesson I
- Introduction, Theory & Components
- Have students read text material ahead of time, if possible.
- Lecture from outline with slide support (about 45 min).
- Assign worksheet (10 - 15 min).
- Correct and discuss worksheet (15 - 20 min).
- Assign final quiz (15 min).

Lesson II
- Process Kinetics and Process Control (Optional)
- Assign text material
- Lecture using overhead or chalk board presentation depending on instructor preference.
- Conduct open discussion
- Design and assign worksheet to match needs and level of specific student group.

Additional Comments:

- A visit to an operating oxidation ditch plant would be desirable. If a visit is possible, have students measure dissolved oxygen around the ditch to emphasize the concept of aerated and anoxic zones.

- For classroom demonstrating provide fresh activated sludge from an oxidation ditch for the students to perform settling rate tests and to observe microorganisms under the microscope.

- Collect samples of raw, primary effluent, and final effluent in jars to compare characteristics.

- Have samples of trend charts for plotting of process control indicators.

OXIDATION DITCHES

LECTURE OUTLINE

Lesson I - Introduction, Theory & Components

Slide #3

History of the Oxidation Ditch Process

Names: Pasveer Oxidation Ditch Process

Loop Aeration

Carrousel Process

Orbital System

Developed in the Netherlands by I.A. Pasveer

First System in 1954

In 1975 there were 558 Oxidation Ditch Plants in the U.S.

Slide #4

Principles of the Oxidation Ditch

Application of the Extended Aeration, Complete Mix Concept of Activated Sludge

A Closed-loop Trench Aeration Tank

Lost Cost Construction - Advantage

Disadvantages due to Aeration Effectiveness, Detention Time, Flow Pattern when Scaled Up Significantly

Slide #5

Multiple-Trench Systems

Multiple Small Units

Carrousel System

Several Circular Tanks One Inside the Other; The Inner Most Tank is the Clarifier, the Outer Tanks the Aeration Basins.

Partitions Channel the Flow

Designs of 5-20 MGD Applicable

Slide #6

Advantages - Estimated to be Cheapest System to Build in the 0.1-4.0 MGD Range

Carrousel Design Make Almost Any Size System Competitive

-Relatively Low Operation Costs

-Tolerates Shock Loads Because of High MLSS and Long Detention Time

-Requires Minimal Operational Guidance

-Nitrification/Denitrification can be Accomplished in Same Basin

Disadvantages - Space Requirement Relatively Large because of Extended Aeration Mode

-Control of Aeration Difficult

The Oxidation Ditch System Components--

Slide #7

The Oxidation Ditch

Trenches Dug into Earth

Free Standing Concrete Basins

Oval or Circular

Slide #8

The Aeration Devices

Rotating Brushes Across the Channel

Whip Oxygen into the Water and Propel the Water Around the Basin

Slide #9

Brush Type - Horizontal Shaft 70-80 rpm

Disc Type - Large, Vaned Discs on Horizontal Shaft, Partially Submerged; 30 rpm

Clarifier

Separation of Solids

Separate Basins & Settling in Aeration Basins

Wasting & Return Sludge Capabilities

Solids Handling

The Aeration Process--

Slide #10

Aeration: 1-3 mg/l D.O.

Ancxic Zone (0 m/l D.O.)

Nitrification/Denitrification

Slide #11

Horizontal Movement

At Least 1 ft/sec

Baffle

Slide #12

Suspended Growth

Organisms and food Mixed and Moving Together

Loading and Operating Conditions--

Slide #13 — Detention Time
- SRT 15-30 Days
- Aeration Time 24 Hours

Slide #14 — Solids Concentration in Basin
- MLSS 4000-6000 mg/l

Slide #15 — Loading Condition
- F/M = 0.25-0.35

Lesson II - Process Control and Process Kinetics

Slide #16 — Process Control
- Evaluating Sludge Settleability
  - Settleometer
  - SVI

Slide #17
- Solids Inventory
  - DOB
    - Solids in Clarifiers
  - MLSS
  - Wasted Solids

Slide #18
- Return Sludge Rate
  - RAS 40-45% of Influent Flow
  - Used to Balance Sludge Inventory
  - Segmented Wasting Schedule
- Waste Sludge Rate (WAS)
  - Methods to Follow Process Should be Trend Charted
    - FM
    - SRT

Slide #19
- Dissolved Oxygen Control
  - Oxygen Profile
- Base Operation on System Response
  - Process Should Dictate Guidelines

Process Kinetics

Oxidation of Organic Carbon Compounds

Oxidation of Organic Nitrogen Compounds

Sources of Nitrogen (NH_4^+ N)

Urine 0.5-3 g/day/adult

Feces 1-2 g/day/adult

Concerns with Nitrogen

Algae Blooms

Toxic Effects

Interference with Disinfection

Impact on pH

D.O. Demand

4.75 mg O_2/mg NH_4^+ N

Slide #20 Nitrification/Denitrification

Slide #21 Balancing Oxidation and Reduction

Promote Nitrification and Allow Carbonaceous Oxidation to Follow

Nitrification

D.O. Residual of 1-3 mg/l

SRT 15-30 day

MLSS 4000-6000 mg/l

pH 6.5-8.0

10:1 alk/NH_4^+

Temp

Denitrification

Facultative Organism Shift Quickly

Anoxic vs anaerobic

Alternating

Anoxic/Aerobic Zones

Daily Operational Activities--

Slide #22, #23, #24	Loading and Operating Ranges Required
	D.O. 1-3 mg/l
Slide #25, 26	MLSS 4000-6000 mg/l
	SRT 15-30 days
	F/M 0.25-0.35
Slide #27	Housekeeping
Slide #28	Equipment Maintenance
	Pumps and Motors
	Clarifiers
	Aerators
	Lab
Slide #29	Safety
Slides #30-34	Review

Name _____

Answers to Worksheet Problems

1. Calculate the volume of an oxidation ditch which has a cross-section as shown below and is 350 feet around in the center of the basin.

$$V = \text{Area} \times \text{Length}$$

$$= 1/2(L_1 + L_2) \times H \times \text{Length}$$

$$= 1/2(20 + 16) \times 5 \times 350$$

$$= 31{,}500 \text{ ft}^3 \times \frac{7.48 \text{ gal}}{\text{ft}^3}$$

$$= 235{,}620 \text{ gal or } 0.236 \text{ Mgal}$$

2. Calculate the aeration time for an oxidation ditch which has a volume of 0.33 Mgal and an influent flow of 260 gpm.

$$\text{D.T.} = \frac{\text{Vol}}{\text{Flow}}$$

$$= \frac{0.33 \text{ Mgal} \times 1{,}000{,}000 \text{ gal}}{260 \frac{\text{gal}}{\text{min}} \times \frac{60 \text{ min}}{\text{hr}} \times \text{Mgal}}$$

$$= 21 \text{ hrs}$$

3. If a float in an oxidation ditch travels 50 ft in 38 sec, what is the horizontal velocity in feet per second?

$$\text{Vel} = \frac{\text{distance}}{\text{time}}$$

$$= \frac{50 \text{ ft}}{38 \text{ sec}}$$

$$= 1.32 \text{ ft/sec}$$

4. Calculate the F/M ratio for an oxidation ditch which has a volume of 1.0 Mgal with MLSS of 5000 mg/l loaded with a flow of 10 MGD and a BOD of 170 mg/l.

$$F/M = \frac{\text{lbs BOD per day}}{\text{lbs MLSS}}$$

$$= \frac{170 \text{ mg/l} \times 10 \text{ MGD} \times 8.34}{5000 \text{ mg/l} \times 1.0 \text{ Mgal} \times 8.34}$$

$$= 0.34$$

5. If the influent flow is 3 MGD and the RAS flow is 875 gpm what is the percent return flow?

$$\text{Percent return} = \frac{\text{Influent Q}}{\text{RAS Q}} \times 100\%$$

$$= \frac{\frac{875 \text{ gal}}{\text{min}} \times \frac{1440 \text{ min}}{\text{day}} \times \frac{\text{Mgal}}{1000000 \text{ gal}}}{3 \frac{\text{Mgal}}{\text{day}}} \times 100\%$$

$$= 42\%$$

Name _____ _____

Final Quiz

Multiple Choice: Choose the best answer(s) and place an "X" in front of the corresponding letter.

1. Which of the following is not a term commonly used to identify an oxidation ditch?

___ a. Pasveer Oxidation Ditch
___ b. Loop Aeration
___ c. Loop Lagoon
___ d. Carrousel Process
___ e. Orbital System

2. The oxidation ditch process was developed in

___ a. England
___ b. United States
___ c. Holland
___ d. Germany
___ e. Denmark

3. The oxidation ditch process is a modification of

___ a. the trickling filter
___ b. extended aeration activated sludge
___ c. RBC's
___ d. ABF
___ e. aerated lagoon

4. The carrousel variation is most applicable to the _____ flow range.

___ a. 0.5-1 mgd
___ b. 0-5 mgd
___ c. 5-20 mgd
___ d. 20-50 mgd
___ e. 50-100 mgd

5. The oxidation ditch is designed to operate at _____ mg/l D.O.

___ a. 0.1-0.5 mg/l
___ b. 1-1.5 mg/l
___ c. 0-2 mg/l
___ d. 1-3 mg/l
___ e. 5-10 mg/l

6. Horizontal velocity of activated sludge around the ditch should be

___ a. 0.5 ft/sec
___ b. 1.0 ft/sec
___ c. 2.0 ft/sec
___ d. 5.0 ft/sec
___ e. 10.0 ft/sec

7. MLSS concentration in the aeration ditch should be

___ a. 500-1000 mg/l
___ b. 1000-1500 mg/l
___ c. 2000-4000 mg/l
___ d. 4000-6000 mg/l
___ e. 8000-10,000 mg/l

8. F/M ratios for aeration ditch loading are in the _____ range.

___ a. 0.01-0.2
___ b. 0.1-0.25
___ c. 0.25-0.35
___ d. 0.3-0.5
___ e. 0.5-1.0

9. Which <u>two</u> tests are used to evaluate sludge settleability?

___ a. volatile solids
___ b. MLSS
___ c. settleometer
___ d. centrifuge
___ e. SVI

10. Wasting sludge from the system will have a long term effect on (choose 3 answers):

___ a. DOB
___ b. MLSS
___ c. sludge age
___ d. BOD
___ e. solids inventory

11. Algae blooms, D.O. demand, disinfection interference, impact on pH and toxic conditions can all be a result of

___ a. excess nitrogen
___ b. excess organic carbon
___ c. excess D.O.
___ d. inadequate oxidation
___ e. stratification

12. The condition in which oxygen is relatively low is called

___ a. anaerobic
___ b. anoxic
___ c. aerobic
___ d. nitrification
___ e. stabilization

13. Which of the following conditions favor nitrification? (choose 3 answers)

___ a. D.O. 1-3 mg/l
___ b. anoxic
___ c. pH 6.5-8.0
___ d. MLSS 4000-6000 mg/l
___ e. low ammonia concentrations

14. Daily operational activities should include (choose 4 answers):

___ a. housekeeping
___ b. safety consciousness
___ c. equipment inspection
___ d. laboratory testing
___ e. sludge hauling

15. Operational control of an oxidation ditch process should be based on (choose the <u>best</u> answer):

___ a. DOB & settleometer
___ b. centrifuge & MLSS
___ c. F/M ratio coupled with a consideration of sludge age
___ d. how the system responds to parameters tracked over a period of time by trend charts
___ e. the phases of the moon

OXIDATION DITCHES

Name _____

Answers for Final Quiz

Multiple Choice: Choose the best answer(s) and place an "X" in front of the corresponding letter.

1. Which of the following is not a term commonly used to identify an oxidation ditch?

___ a. Pasveer Oxidation Ditch
___ b. Loop Aeration
X c. Loop Lagoon
___ d. Carrousel Process
___ e. Orbital System

2. The oxidation ditch process was developed in

___ a. England
___ b. United States
X c. Holland
___ d. Germany
___ e. Denmark

3. The oxidation ditch process is a modification of

___ a. the trickling filter
X b. extended aeration activated sludge
___ c. RBC's
___ d. ABF
___ e. aerated lagoon

4. The carrousel variation is most applicable to the _____ flow range.

___ a. 0.5-1 mgd
___ b. 0-5 mgd
X c. 5-20 mgd
___ d. 20-50 mgd
___ e. 50-100 mgd

5. The oxidation ditch is designed to operate at _____ mg/l D.O.

___ a. 0.1-0.5 mg/l
___ b. 1-1.5 mg/l
___ c. 0-2 mg/l
_X_ d. 1-3 mg/l
___ e. 5-10 mg/l

6. Horizontal velocity of activated sludge around the ditch should be

___ a. 0.5 ft/sec
_X_ b. 1.0 ft/sec
___ c. 2.0 ft/sec
___ d. 5.0 ft/sec
___ e. 10.0 ft/sec

7. MLSS concentration in the aeration ditch should be

___ a. 500-1000 mg/l
___ b. 1000-1500 mg/l
___ c. 2000-4000 mg/l
___ d. 4000-6000 mg/l
_X_ e. 8000-10,000 mg/l

8. F/M ratios for aeration ditch loading are in the _____ range.

___ a. 0.01-0.2
___ b. 0.1-0.25
_X_ c. 0.25-0.35
___ d. 0.3-0.5
___ e. 0.5-1.0

9. Which <u>two</u> tests are used to evaluate sludge settleability?

___ a. volatile solids
___ b. MLSS
_X_ c. settleometer
___ d. centrifuge
_X_ e. SVI

10. Wasting sludge from the system will have a long term effect on (choose 3 answers):

___ a. DOB
_X_ b. MLSS
_X_ c. sludge age
___ d. BOD
_X_ e. solids inventory

11. Algae blooms, D.O. demand, disinfection interference, impact on pH and toxic conditions can all be a result of

X a. excess nitrogen
___ b. excess organic carbon
___ c. excess D.O.
___ d. inadequate oxidation
___ e. stratification

12. The condition in which oxygen is relatively low is called

___ a. anaerobic
X b. anoxic
___ c. aerobic
___ d. nitrification
___ e. stabilization

13. Which of the following conditions favor nitrification? (choose 3 answers)

X a. D.O. 1-3 mg/l
___ b. anoxic
X c. pH 6.5-8.0
X d. MLSS 4000-6000 mg/l
___ e. low ammonia concentrations

14. Daily operational activities should include (choose 4 answers):

X a. housekeeping
X b. safety consciousness
X c. equipment inspection
X d. laboratory testing
___ e. sludge hauling

15. Operational control of an oxidation ditch process should be based on (choose the best answer):

___ a. DOB & settleometer
___ b. centrifuge & MLSS
___ c. F/M ratio coupled with a consideration of sludge age
X d. how the system responds to parameters tracked over a period of time by trend charts
___ e. the phases of the moon